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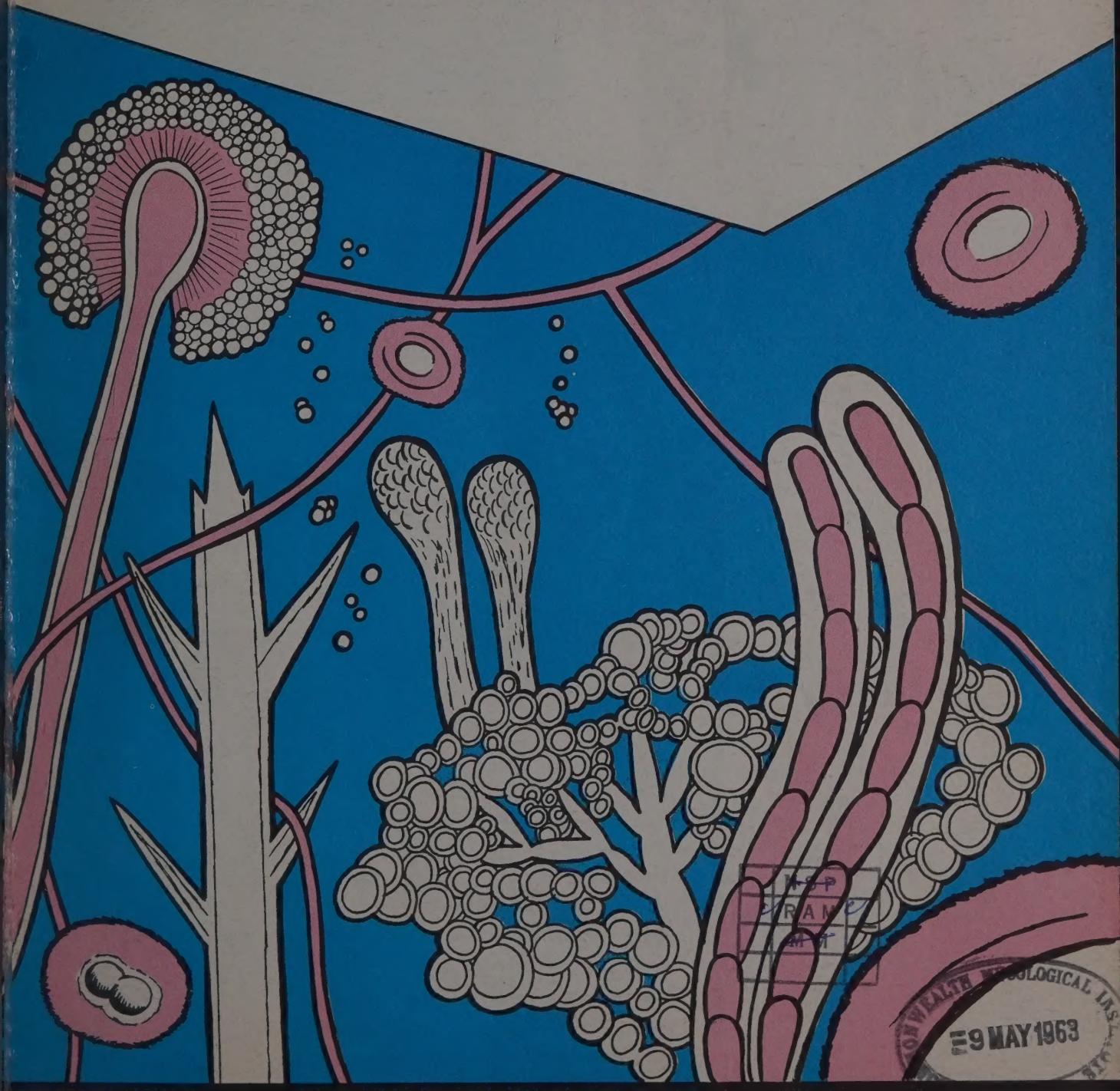
What you should know about PLANT DISEASES



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What you should know about PLANT DISEASES

A wonder-world of micro-organisms is illustrated on the front cover. These fungi are too small to be seen by the unaided eye but exist and work both for and against man in his struggle for survival. Our knowledge of them assures us of a more abundant life and their study can be both pleasant and rewarding.

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What You Should Know About

PLANT DISEASES

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THE ALERT FARMER, ranchman or home owner who can identify plant diseases will be more successful at growing plants. If necessary, he seeks the advice of specialists and uses control recommendations carefully.

Plant diseases can be more serious than most people realize. For instance, in 1852 all of the people in a French town became ill and many died. A search for the cause revealed that bread made from grain containing "ergot" caused this epidemic. Ergt is a small black, hard, sausage-shaped body which develops in place of a rye, wheat or barley kernel after a certain fungus has entered the head of the grain. Ergot disease affects blood circulation and, in some cases, the nervous system.

From 1845 to 1860, plant disease caused a disaster in Ireland. Late blight struck the potato-growing region and turned the fields into a blackened, rotting mass. A million people died because the potato crop failed; numerous families migrated to other countries. Potato farmers have been troubled with this disease since that time.

In the United States, plant disease epidemics have taken their toll. In the early 1900's, "chestnut blight" killed most of the chestnut trees in the U. S. In 1946, an oat disease, Victoria blight, destroyed fields of the best varieties in the midwest. Fortunately, varieties not hurt by Victoria blight were developed quickly to replace the diseased ones.

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Year after year, plant diseases continue to destroy the farmer's crops, gardener's vegetables, homemaker's flowers and shrubs and trees and lawns which beautify our homes. Some cause human illness and loss of livestock by poisoning foods.

Many diseases can be controlled or prevented, but some remain for the scientist to study and conquer. Through proper understanding of disease development in plants and the correct methods of prevention and control, we can combat most of them successfully.

WHAT IS A PLANT DISEASE?

A plant disease is a condition in which any part of a living plant is abnormal or which interferes with the normal activity of the plant's cells or organs. As a result an abnormal condition in the plant is produced which is called a disease symptom. For example, leaf spots, stunting and blights are symptoms of disease.

Causes of Plant Diseases

Plant diseases are caused by fungi, bacteria, viruses and nematodes. All of these forms of life are not detrimental. Many are beneficial, in that they break down organic matter and perform other functions helpful to man. Recognition of plant disease organisms helps one distinguish between the beneficial and the harmful ones.

Fig. 1. Cotton leaves damaged by hormone-type herbicides. These chemicals often drift from areas being treated to control weeds to nearby plants.

Micro-organisms are everywhere. Thousands of bacteria are present in the human mouth. Fungi appear as molds on old bread. Viruses may be transferred from plant to plant by insects or other means. Nematodes are found in all natural soils. They are desirable as long as they do not limit man's food supply or hinder his well-being. A good understanding of the nature of these organisms is necessary to learn about their control.

Parasitic and Nonparasitic Diseases

Parasitic is a term derived from the base word, parasite, which means that an organism gets its food from a living plant or animal. Therefore, disease-causing fungi, bacteria and nematodes are parasitic upon plants because they obtain their living from them.

Nonparasitic diseases refer to conditions produced in the plant by such things as nutrient deficiency, lack of water or unfavorable temperatures. In such cases, the plant is not being attacked by an organism but is affected by environmental conditions. See figure 1.

STRUCTURE OF PLANTS

An understanding of plant structure is necessary for individuals who attempt to identify and control plant diseases. All plants are composed of cells, each type having a special job to do. Figure 2 shows the location of these cells and the following discussion tells how they function as a unit for the good of the entire plant.

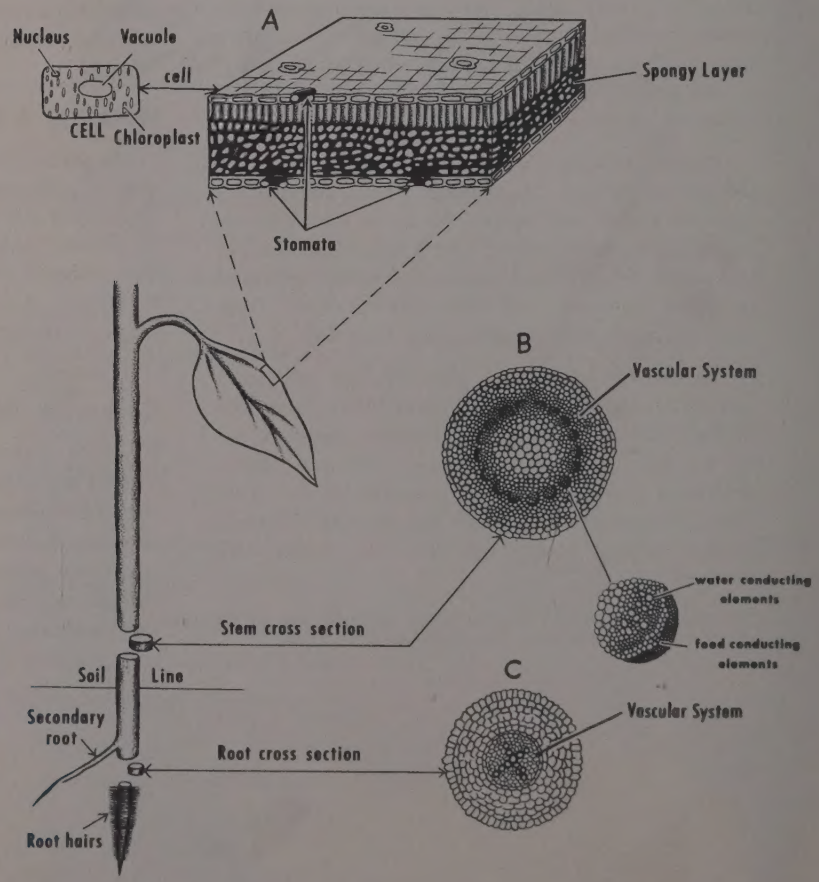


Fig. 2. Diagramatic presentation of plant parts.
A. Cross section of a leaf showing individual cells.
B. Cross section of a stem showing the arrangement of specialized cells.
C. Cross section of a root.

Roots

These underground plant organs serve the plant by absorbing water and necessary minerals from the soil. They also support the plant in an upright position. Food that has been manufactured in the leaves also may be stored in the roots, such as in sweetpotatoes.

Cells in mature roots are similar in arrangement to those in the stems. The root cross section in figure 2 shows xylem and phloem vessels that assist in the transport of minerals and food materials.

Stems

The primary purpose of the stem is to transport food and minerals and support the leaves in a position where they will receive the greatest amount of sunlight. The stem cross section in figure 3 shows the xylem vessels that transport minerals and water up the stem and the phloem that carries food material to various parts of the plant.

Leaves

A leaf is a thin, expanded organ having a large surface which permits a great number of the cells to be exposed to sunlight. These leaf cells contain chlorophyll, a green pigment, that gives the leaf its color. The chlorophyll particles take energy from the sun's rays and change it into a form of energy that can be used by the plant in manufacturing food. The leaf has specialized structures called stomata that let carbon dioxide and oxygen in and out of the leaf.

Photosynthesis, the manufacture of sugars from carbon dioxide and water with the aid of sunlight and chlorophyll, takes place when all of the factors involved are present in sufficient amounts. The resulting photosynthetic process is shown by the following diagram:

$$\text{CARBON DIOXIDE} + \text{WATER} \xrightarrow[\text{Sunlight produces}]{\text{With the aid of Chlorophyll}} \text{SUGARS} + \text{OXYGEN}$$

If nematodes are feeding on the roots and stunting their development, a plant's rate of photosynthesis may be limited by the amount of nutrients and water it receives. Therefore, if food production is limited, plant growth is limited.

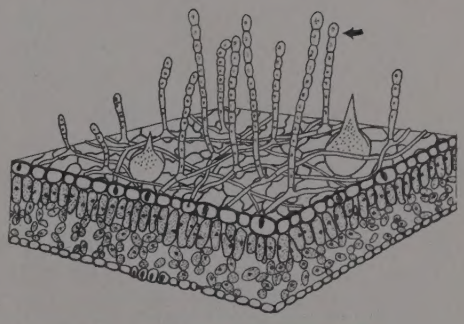
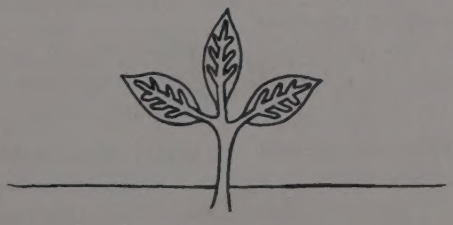


Fig. 3. Typical growth of powdery mildew on a leaf showing formation of spores (see arrow).



Symptoms of Plant Diseases

Symptoms are the effects produced by a disease organism on a plant. This is the appearance of the plant after supporting a particular disease parasite. To be efficient in identifying plant diseases and recognizing their symptoms, one should be familiar with the following terms:

BLIGHT—The rapid discoloration and death of tissue over certain portions of the plants. This usually results in the general killing of leaves, flowers and stems. Examples of this are the bacterial disease, fire blight, on pears and bacterial blight of cotton.

CANKER—A dead area on a stem surrounded by living tissue. Brown canker on the stems of roses is an example of this condition.[1]

CHLOROSIS—Yellowing of normally green tissues due to partial failure of chlorophyll to develop. Iron deficiency often produces this effect in areas where available iron is lacking in the soil.

CURL—A puff-like distortion on a leaf resulting from the unequal development of its two sides. Peach leaf curl is a common example of this condition.

DAMPING-OFF—A disease of seedling plants usually caused by fungi. Early planted cotton often is affected by this disease and the disease sometimes is blamed on cool weather.

DIEBACK—Progressive death of branches, shoots and roots beginning at the tips. This type of condition is characteristic of unhealthy trees or shrubs.

DWARFING—The failure of any part of the plant or the entire plant to develop properly. With the exception of dwarf varieties, this condition usually is produced by nutritional deficiencies or a disease organism.

GALL—A pronounced localized swelling occurring on roots, stems and branches. The stimulation for development may be caused by a disease organism, insect or a wound.

HOST—The plant on, or in which, the parasite is living and obtaining its food.

[1]"Roses for the Home," USDA Home and Garden Bulletin No. 25.

INFECTION—The establishment of a disease-producing organism on or within a host.

LESION—A localized spot of diseased tissue. Spots, blisters and scabs are examples.

MILDEW—A plant disease caused by a fungal organism which forms a whitish or grayish coating over the surface of leaves.

MOSAIC—Symptom of a virus disease appearing as dark green, light green, white or yellowish irregular spots on the leaves of affected plants.

MUMMY—A dried, shriveled fruit resulting from certain fungal diseases. Old mummified fruits may be found under peach trees. They serve as a means of infection for the next year's crop.

PUSTULE—Small raised blister-like areas on the surface of leaves or other plant tissue. They usually burst to free a spore mass which starts new infections.

RESISTANCE—The inherited ability of the plant to retard growth of certain disease organisms.

RING SPOTS—Yellowish rings on the leaves with green tissue inside the ring. This usually is associated with virus diseases.

ROSETTE—A disease symptom in which stems are shortened, producing a bunchy growth habit. This symptom may be observed where there is a zinc deficiency in pecans.

ROT—A state of decomposition produced by a micro-organism.

RUSSET—Brownish roughened areas on the surface of fruits caused by diseases, insects or spray injury.

SCAB—A crust-like disease lesion, produced as a result of disease infection. Pecan scab is an example.

SPORE—A reproductive unit of a fungus that functions much like seed of green plants.

VECTOR—An agent that transmits disease producing organisms. Insects are common vectors of plant disease organisms.

WILT—Loss of freshness due to inadequate moisture. This condition usually is caused by a disease condition stopping up the water transporting vessels of a plant.

FUNGI

Fungi are tiny, thread-like microscopic plants, commonly called molds. (See cover.) Fungi are living plants. They require a source of energy but, unlike green plants, cannot use energy from the sun to make their food. They must get food from external sources such as other living plants. When these plant-feeding fungus types become numerous a disease epidemic develops.

Many fungi reproduce by the formation of spores, figure 3. These spores are produced on the tips of the filaments in specialized structures. Spores are produced in fantastic numbers, sometimes millions, on a single plant. Many never find lodging on a desirable host, but because spores are in such large numbers, reproduction continues. Under favorable conditions, a spore landing on a susceptible plant can produce a new infection center.

Symptoms of disease caused by fungi are numerous. Many fungi are associated with leaf spots and fruit rots, but certain kinds live in the soil and attack roots and stems. When a spore germinates, it produces a thread-like strand which acts as an infection element, Figure 4. The infection element of certain fungi is capable of penetrating into a plant directly; others must enter through the plants' breathing pores or wounds. Plants have many microscopic breathing pores called stomata on the surface of their leaves. This is a common source of infection. Once the fungal infection element becomes established inside the plant, numerous strands of hyphae start growing and feeding in the plant tissues. Invaded tissue gradually dies as the fungus feeds on it.

Fungi may overwinter as weather-resistant spores or vegetatively in some form of decaying organic material. When weather conditions become favorable, growth begins and a new infectious process starts. Most common fungi grow best at relatively high temperatures and high humidities.

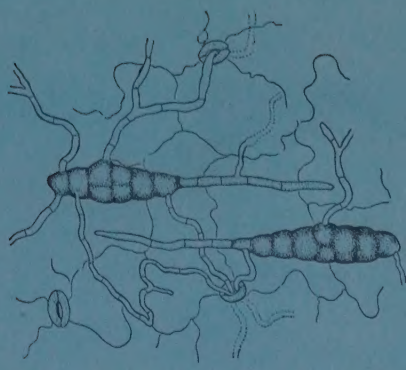


Fig. 4. Germinating spores sending out threadlike strands that are entering leaf stomata.

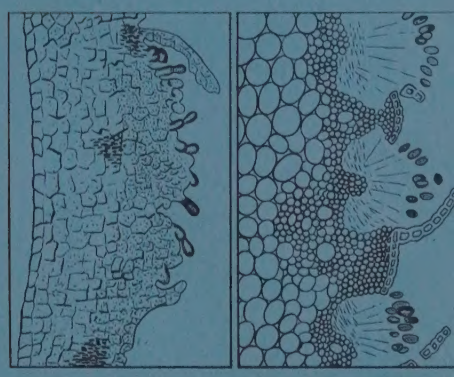


Fig. 5. Rust pustules that are borne on stems and leaves of small grains rupturing to free spores produced in them.

SYMPTOM TYPES CAUSED BY FUNGI

Rust on Wheat

Two types of rust affect wheat in Texas. Stem and leaf rusts which cause extensive damage are recognized by the reddish pustules that appear on the surface of leaves or the stem.

Stem rust is the most dreaded wheat disease because of its severe damage to grain yield and quality. It is caused by a parasitic fungus which enters the leaves, stems or spike through stomata. In 6 to 10 days the fungus begins reproducing and appears as brick-red, elongated pustules on the surface of the plant parts. These pustules contain thousands of microscopic spores, figure 5, which may be carried by wind currents to nearby plants. There they germinate in rain or dew and cause new infection. When infection is high the stems are weakened, the plants lodge, the grain is shrivelled and yields are low. The disease movement is shown in figure 6.

Fig. 6. This map shows how rust spores are blown by the air at different times of the year to infect wheat throughout the chief wheat growing areas

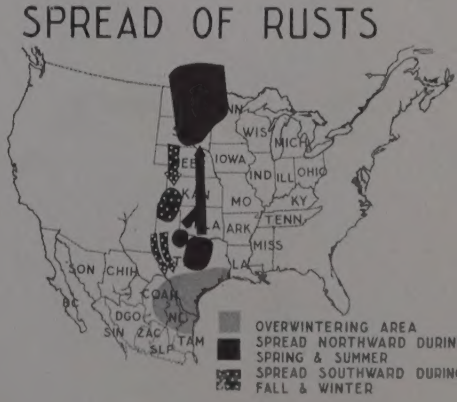


Fig. 7. Seedling disease of cotton is caused by a complex of micro-organisms that may kill the plant before its emergence from the soil, after it emerges or cause the root systems of mature plants to be deformed.

Fig. 8. Cotton plants dying from cotton root rot. This fungus disease attacks over 1,700 kinds of plants including fruit and shade trees, shrubs, flowers and vegetables. Plants usually begin to die about midsummer.

Fig. 9. Typical leaf spots produced by fungi. This illustration shows characteristic spots produced on tomato and potato when affected by early blight.

Seedling Disease

As the name implies, seedling disease organisms attack the young plant shortly after germination, either before or after they emerge from the soil. Lesions or dead spots are visible on the young plants near the soil line, figure 7. These lesions may cause death or severe stunting.

Because cotton farmers are concerned about the disease, extensive research is in progress. Farmers who planted their cotton in early spring formerly attributed this condition to cold weather. During the last few years research has proved that cotton may be planted much earlier if fungicides are mixed in the soil at time of planting. Growth of these fungi is favored by cool soil temperature.

This disease is caused by several common soil fungi which feed upon organic matter in the soil. However, they can readily use tender living tissue, such as that provided by young seedlings of cotton, beans and peanuts, as a source of food. This condition can be prevented by use of the newer soil-treating fungicides.

Cotton Root Rot

Cotton root rot usually is found in heavy alkaline soils and is especially destructive in the Texas Blacklands. About 80 percent of the wild and cultivated plants are susceptible.

The first symptom of this disease is sudden wilting of the plant, figure 8. When it is pulled from the soil, the bark of the roots is dead and may slip easily. When moist conditions prevail, a white cushiony spore mat may appear on the soil surface near affected plants.

Cotton, alfalfa and some ornamentals and trees are very susceptible to cotton root rot. This disease can be controlled best by growing resistant crops, deep plowing and deeply turning under a large amount of plant residue (dry or green organic matter).

Leaf Spots

Early blight of tomato and potato results in a typical leaf spot symptom. These spots are circular to angular and black to dark brown, figure 9. When a number of these spots are present, leaves shed and die prematurely.

Stems and fruits also may become affected, causing weakened branches and spotting and shedding of the fruit as in the case of the tomato. The most effective control known to date is the use of newer fungicides.

Another example of the leaf spot type is the black spot of roses.

Leaf Curl

Peach leaf curl is common in many areas of Texas. This is a fungal disease that appears in the spring shortly after the leaves begin to develop. The leaf itself becomes puckered along the mid-rib, figure 10. The leaves turn pale green to yellow and drop from the tree.

The fungus overwinters on the limbs and branches and can be controlled more effectively during the winter. Fixed coppers as winter sprays are effective as are some of the newer fungicides.

Cankers

Many diseases exhibit their symptoms in the form of cankers. Dead areas appear on the stem or branch.

Cankers are common on roses and one of the most common is brown canker. The stem spots produced by this disease begin as small purplish areas, and as they enlarge, the center turns white. They then appear as white spots surrounded by a reddish-purple margin. Many of these spots may be found on a single cane, figure 11.

Prevention is the best approach in controlling canker disease. If the plants are healthy and if care is taken with pruning, one should have little difficulty with this disease.

Infected branches should be removed at the time of spring pruning. A dormant lime-sulfur spray of 1 to 10 dilution may be used after pruning to eliminate spores which may have been spread in the process.

Wilts

Fungi causing wilts often build up in soil on which susceptible crops were grown for several seasons. These fungi are able to penetrate the roots, grow up the stem and plug nutrient-transporting vessels. Plants affected in this manner may revive during the night and wilt the following day. After a few days the plant dies. The Fusarium wilts are very common in Texas on tomatoes, watermelons, cotton and other plants of economic importance, figure 12.

Fig. 10. Puckering of the leaves is the typical symptoms of peach leaf curl.

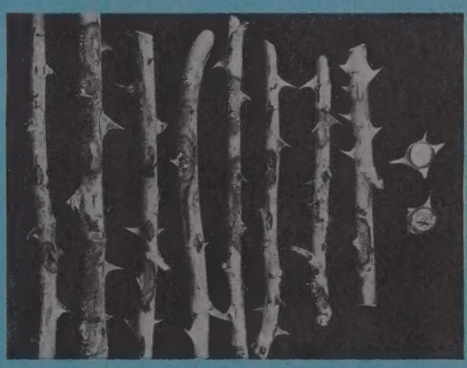


Fig. 11. Brown canker of rose. Note the dead areas surrounded by living tissue producing the typical canker effect.

Fig. 12. Drawing of a tomato plant showing the effects of wilt. Leaves and stems lose their rigidity and hang downward.

BACTERIA

Bacteria are the simplest forms of plants. They are so tiny that if 8,000 to 12,000 were placed side by side they would not exceed an inch.

Even though bacteria are small and consist of only one cell, they multiply at an enormous rate. This increase in number is carried out by division. Redivision may vary from 20 minutes to several hours. In some of the faster multiplying types a single bacterium could produce over 47,000,000,000 descendants in a 12-hour period.

Fortunately, most bacteria are beneficial to mankind. Some cause human disease, however, and 170 different kinds of bacteria are capable of feeding on green plants and producing a disease condition. Bacteria cannot penetrate directly into plants. They must make entry through the breathing pores, wounds or be deposited by a feeding insect, figure 13.

Unlike fungal spores bacteria usually are killed easily by drying. Most of the common carriers of disease such as insects, animals and farm machinery efficiently transmit bacteria. Certain bacteria may remain alive in infected seed or storage organs such as potato tubers, flower bulbs and others.

Different species of bacteria affect plants in various ways and their symptoms may be expressed as wilts, leaf spots, galls, soft rots and blight.

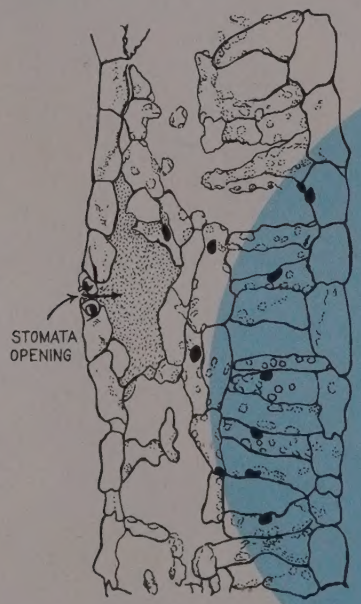


Fig. 13. Bacterial cells enter plants by means of wounds or natural openings. Here they are shown entering through a stoma and occupying spaces between the cells.

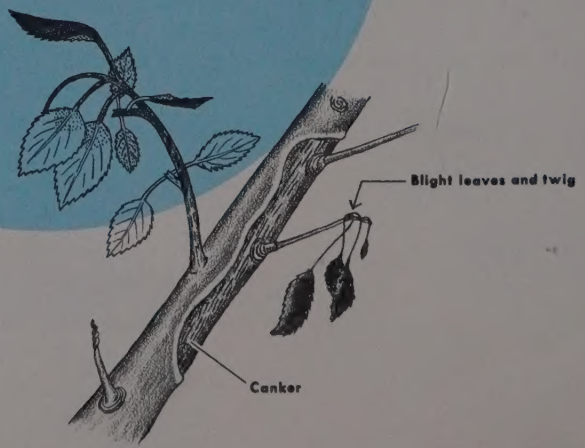


Fig. 14. Typical fire blight symptoms on leaves and twigs. They appear as though they had been burned.

SYMPTOM TYPES PRODUCED BY BACTERIA

Blight

The term blight refers to a rapid discoloration and death of tissue over certain portion of plants. Severe cases of infection may result in the death of affected plants.

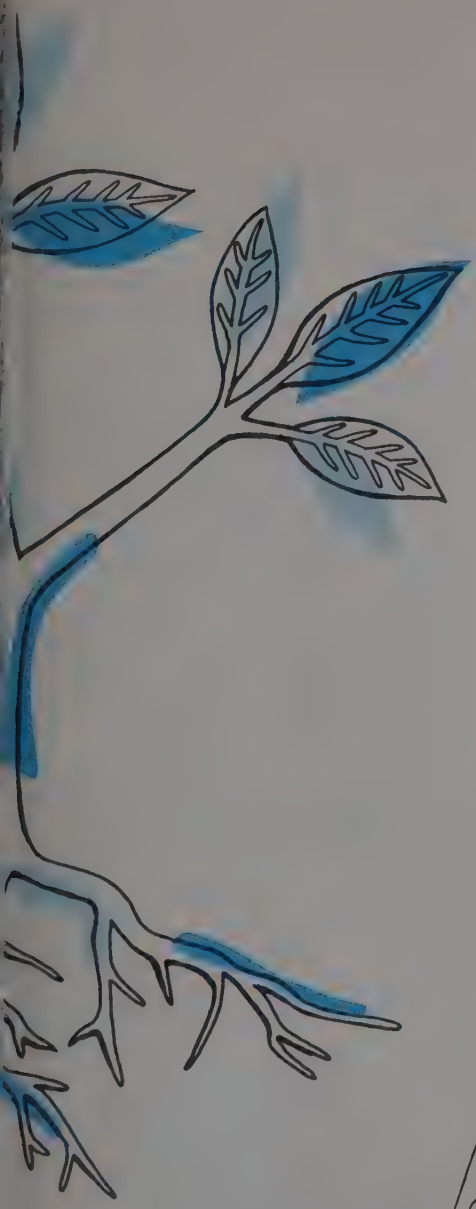
One of the most common and destructive blights is fire blight of apple and pear. The disease also occurs on apricot, loquat, spirea, photinia and pyracantha. During the spring, this disease may spread over an entire orchard and kill most of the growth. Upon dying, leaves turn black, remain on the trees and appear severely scorched, figure 14.

Primary infection usually is brought about by bacteria-carrying insects feeding and walking about on the flowers and leaves. Bees, flies and ants are attracted most to the nectar-filled flowers; and, after having visited and infected a blossom, pick up bacteria and transfer them to other flowers.

After a sufficient number of blossoms and leaves have been infected, a wind-blown rain may spread the bacteria to other tree parts and other trees. Thus this disease usually spreads more rapidly during wet years.

Fire blight causing bacteria overwinter in cankers on the bark. When warmer weather comes in the spring, the bacteria multiply and a bacterial ooze emits from these cankers. The life cycle of the fire blight organism is shown in figure 15.

The most effective means of control is to prune out infected canker areas well below the canker itself during the fall or winter season. Some varieties are resistant, but few produce high-quality fruit. Applications of fungicidal sprays during the blossoming period help prevent new infections.



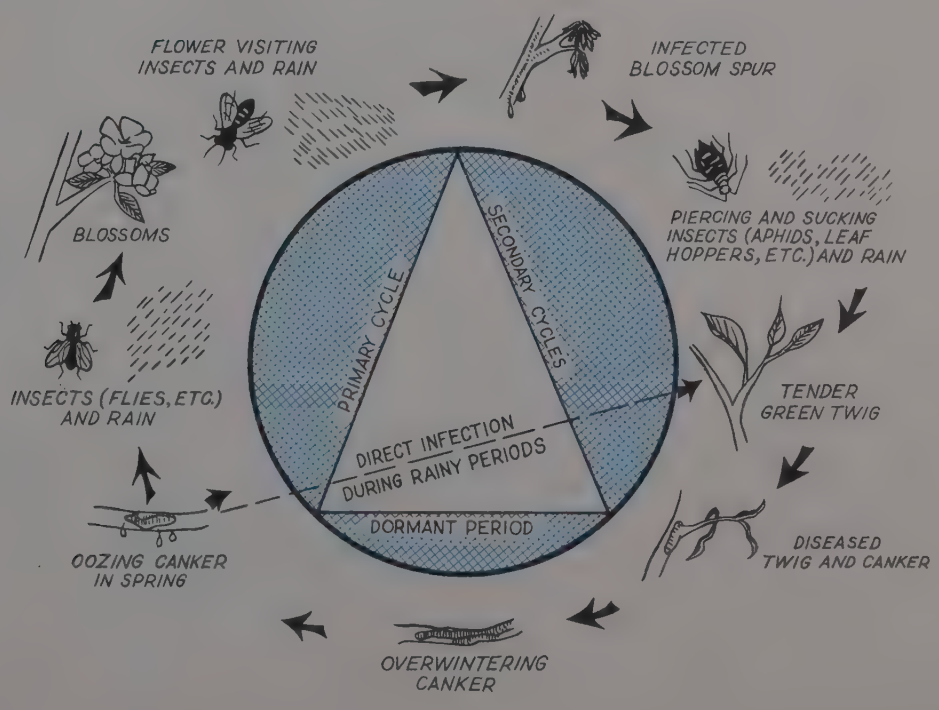


Fig. 15. Life cycle and means of spread of the fire-blight organism.

Gall

Crown gall that appears on roses, grapes, fruit trees and blackberries is typical of bacterial-produced galls. These galls are found most commonly on roots of plants but occasionally may be observed on above-ground parts, especially if the disease-producing bacteria are introduced during budding or grafting. A bacterium gains entrance into plant tissue through natural opening or wounds in the plant usually caused from improper handling, hoeing or cultivation.

This disease occurs as large, round, woody swelling on the limb, trunk or roots of infected plants, figure 16. The gall consists of many small abnormally produced plants cells that results from stimulation of the bacteria. Actually, few bacteria can be found in these galls. Galls appear on the roots and are not discovered until the plant is removed from the soil to make room for a replacement.

Younger plants are affected more severely and often die; whereas, older plants may live for long periods even though they are stunted and unhealthy. To prevent this type of disease, select nursey stock carefully, making certain that plants are healthy. If your soil is infested, you may fumigate it to prevent infection of new plants.

Fig. 16. Crown gall on peach. Galls are most often on the roots or at the ground line.

Wilt

Bacterial wilts are caused by a rapid multiplication of bacteria and the formation of slime that plugs the food and water-conducting vessels of the plant. This causes the plant to wilt and die. Plants affected in this manner usually wilt and revive overnight for 2 or 3 days before death, (Similiar to wilt symptoms shown in figure 12).

An example of wilting can be found in tomato infected with bacterial wilt. One may observe this condition any time from the seedling stage to maturity. The disease-producing bacteria overwinter in or on the seed and become active at the time of germination. Contaminated seed may appear wrinkled and tarnished. Unfortunately chemical seed treatment will not help since the bacteria are inside the seed. Select your seed from companies who purchase seed grown in the dry areas of western states where the disease does not develop. Its pays to buy certified seed instead of saving seed from year to year or buying from an unreliable source.

Leaf Spot

Angular leaf spot (bacterial blight) of cotton is a widely distributed bacterial disease of cotton and a common example of the leaf spot symptom. The bacteria enter the plant through natural openings (stomata) in the leaves, causing a breakdown between cells of the spongy tissues and a release of the cellular juices. For this reason, young lesions will appear watersoaked. The resulting leaf spot actually consists of cells that have been dissolved away from the surrounding cells and have had most of their contents removed, figure 17.

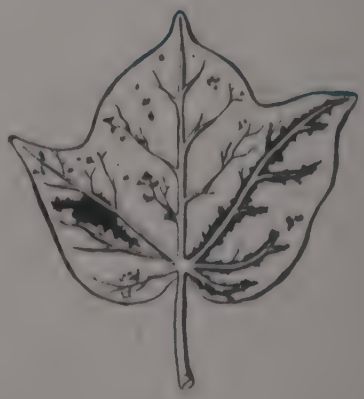


Fig. 17. Angular leaf spot of cotton. Individual spots are confined between the veins giving them a definite angular shape.

Soft Rot

Bacterial soft rot is common to all vegetables and is readily found on grocery store produce counters when the stock ceases to be fresh. It occurs in the field, as a rule, only when some other disease has helped it gain entrance or when the plant has been injured mechanically.

Harvesting, handling and freezing injuries encourage development of soft rot bacteria in plant tissue. Best control is accomplished by being careful in handling and processing, disposing of infected material and storing in temperatures slightly above freezing.

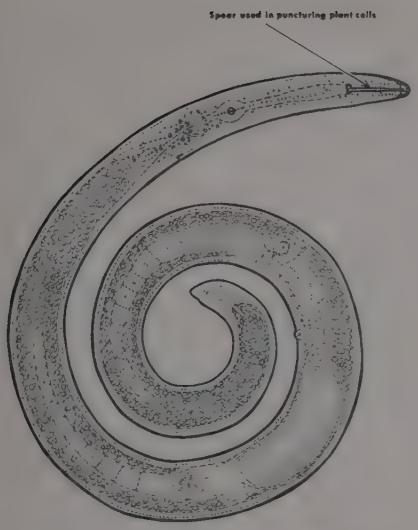


Fig. 18. General shape of a nematode. They may range in length from 0.2 mm to 10.0 mm but most of the plant parasitic types range below 2.0 mm.

NEMATODES

Nematodes that attack plants are round, slender, thread-like worms about 1/70 of an inch long, figure 18. They are equipped with a tiny spear mechanism which they insert into the plant to withdraw plant juices. Some feed from the outside of the roots; others feed by tunneling through the plant roots. Stem nematodes feed on the buds, leaves and stems of plants.

Root knot nematodes probably are the most common type. Their feeding causes abnormal enlargement of root cells in their feeding area. The roots become a distorted mass of uneven swellings, figure 19. Do not confuse this with nodules on legumes caused by beneficial nitrogen-fixing bacteria.

Plants affected by nematodes exhibit a yellowing or lose color and lack vigor. In some instances nematodes injure plants and cause them to be more susceptible to other disease.

You can control nematodes by chemical means. Before spending a large amount of money for chemicals, determine if nematodes are causing a significant amount of damage to justify the expense and labor.

Take care in selecting transplants since they can spread nematodes to new areas.

Fig. 19. Root knot galls on lima beans. Galls are produced as a result of feeding and presence of the nematodes inside the roots.

SYMPTOM TYPES PRODUCED BY NEMATODES

Above-ground Symptoms

Plants affected with nematodes appear unhealthy and weak. This indicates that nematodes are attacking the below-ground portion of the plant. Actually the nematodes are drawing food from the roots, that the plant has manufactured through the process of photosynthesis and would use later for growth and development. This type of damage is sometimes confused with the lack of soil nutrients or soil water.

Nematode-affected plants have less ability to withstand lack of fertilizer, lack of water or any adverse condition. Many times the leaves are small, off-color and are shed before normal shedding time. Therefore, when the leaves that produce food for the plant are unhealthy or few in number, the plant cannot produce fruit or flowers efficiently.

Below-ground Symptoms

Lack of Root Development

Many nematodes that feed upon roots cause root growth to cease. Because of this, a dificient root system results. Roots must be normal and in sufficient number to be able to gather nutrients for plant feeding.

Several different nematodes may cause this condition. If nematodes are suspected, send a pint of soil in a plastic freezer bag to the Plant Disease Diagnostic Laboratory, The A&M College of Texas, College Station, Texas for an analysis and identification. Select the sample from moist soil around the root zone of the suspected host plant and take proper caution to prevent it from drying in shipment.

Root Knots

The root knot nematode is common in Texas. It enters the roots and becomes enlarged, thus producing a gall. This condition should not be confused with crown gall or nodules on the roots caused by nitrogen-fixing bacteria.

Figure 19 shows these knots to be woody-like swellings of the root. Some plants are resistant to root knot nematodes; others are very good hosts. Tomato and okra are susceptible and examination of either of these plant roots will confirm soil infestation.

Fig. 20. Tobacco mosaic virus on tomato. Note the light and dark-green mottling.

VIRUSES

Viruses attack many forms of life including bacteria and plants. Virus particles, rod or spherical in shape, are so tiny that only an electron microscope makes them visible.

Virus particles may enter plants by mechanical inoculations, insect feeding, or vegetative propagation. Cigarette smokers are common carriers of tobacco mosaic virus and transmit it to tomato and related plants. Viruses also are carried in seed, tubers and bulbs.

Viruses can cause leaf spotting, stunted growth and death of the plant. In some plants, however, viruses are present but fail to show symptoms.

The best method of controlling viruses is to avoid infected planting stock, seeds and bulbs. Viruses are not easily detected and infected shrubs may be sold by nurserymen who are unaware of the disease condition.

SYMPTOM TYPES PRODUCED BY VIRUSES

Tobacco Mosaic Virus on Tomatoes

This virus produces a mild mottle, light and dark-green spots, on tomatoes, figure 20. Leaves may become drawn and appear crinkled.

Transmission is caused by aphids infesting the plants and smoking workers who handle the plants. Over half of smoking

tobacco sold contains tobacco mosaic virus. People who smoke may wash their hands in cow's milk before handling plants, to prevent transmission.

Other infection is caused by infected plant debris in the soil. This virus is distinctive inasmuch as it remains in plant residue for long periods.

As a preventative, do not plant tomatoes in soil infected with plant residue. It is equally important to take care in selecting tomato plants. Strict sanitation in growing and handling plants also is important.

Other Symptom Types

Other virus diseases display symptom types of curly top, ring spot and yellows. They are somewhat similar in habit to the aforementioned tobacco mosaic virus.

NUTRIENT DEFICIENCY SYMPTOMS

NITROGEN—Leaves are pale and light-green. Growth is stunted; stalks are more slender than normal. Lower leaves are more yellow than higher leaves and turn brown later.

PHOSPHORUS—Foliage remains dark green with the lower leaves turning purplish around the midribs. Leaves drop early and fruiting is delayed.

POTASSIUM—Leaves near the base of the plant become mottled; leaf tips die and curl under. Yellowing begins at the leaf edges and continues toward the center.

IRON—Leaves yellow when iron is not available in sufficient amounts to manufacture the chlorophyll. There may be a sufficient amount of iron in the soil but an alkaline condition can prevent its availability. Iron chlorosis occurs more often in West Texas. Spraying the foliage or making soil applications of iron chelate or iron sulfate can correct this condition.

ZINC—Pecans are affected by zinc deficiency more than other plants. Young leaves near the tips of the upper branches are small and yellow. There is a rosetting effect produced that results in a number of branches shooting out closely together at the stem tip. Zinc-containing compounds may be sprayed on the foliage.

MAGNESIUM—Lower leaves turn yellow but show no sign of spotting until later stages of growth. Yellowing begins at the leaf tip and progresses downward, inward along the margins and between the veins. Leaf margins may curve upward and pucker.

OTHERS—The previously mentioned elements do not include all that are known to be essential. However, they include the ones most common in occurrence. In isolated cases, deficiencies of calcium, sulfur, boron, manganese and other elements may be noticed.

NUTRIENT EXCESS—Occasionally fertilizer mixtures are applied in excessive amounts. This may burn the plant or increases its disease susceptibility. Soil tests should be made and recommendations followed to eliminate the problem.

UNUSUAL DISEASE CONDITIONS

OEDEMA—This condition is common on some ornamentals when moisture conditions are excessive. Small masses of tissue expand and break out on the surface, causing a watery swelling or gall. Sometimes these galls appear

Fig. 21. Fasciation of a chinaberry limb.

Fig. 22. Mistletoe growing on a tree limb.

Fig. 23. Dodder as it appears on many field, house and garden plants.

rusty and are mistaken for rust. This abnormality may be corrected by reducing the amount of watering.

WITCHES BROOM—(Fasciation or proliferation)—This condition whereby a large number of leaves on stems arise from a single node or small area on a limb, figure 21. This disease may be caused by certain fungi, bacteria, viruses or nutrient deficiencies.

OTHER CONDITIONS WHICH MAY CAUSE PLANT INJURY

1. Drying winds
2. Excessive light
3. Excessive lime in the soil
4. Over-use of commercial fertilizer
5. Gas injury

PARASITIC OR SAPROPHYTIC PLANTS

MISTLETOE—Mistletoe is a parasitic flowering plant with thick green leaves and small white flowers, figure 22. These white flowers later develop into small white berries. The plant obtains water and food from the tree, which weakens and sometimes kills the tree. Pruning limbs and removing growth are the most satisfactory methods of control.

LICHENS—Lichens consist of grayish-green paper-like growth that attaches itself to the bark of trees. It occurs mostly in humid areas and does not harm the tree.

MOSS (Spanish and ball moss)—Spanish moss hangs from trees in long strands. It uses the tree as a means of attachment; not as a source of food and water which it obtains from the air.

Ball moss attaches itself to the tree in a similar manner and appears as fluffy balls of pale green spikelets. Like Spanish moss, it is nonparasitic.

DODDER—Dodder is a parasitic plant that is pale green to yellow, figure 23. After the seed germinate, the young seedlings attach to any plant within reach. The leafless, almost rootless, shoot rotates until it comes in contact with a host plant.

The shoot coming into contact with the host plant begins to climb and encircles it. When the dodder stem has made close contact with the stem of the host, small suckers grow out of it like warts and penetrate the food tissue of the host plant, figure 22. Henceforth, the parasite obtains all its food material and water at the expense of the host plant. Dodder flowers from late spring until frost. Seed are formed in abundance during much of the summer and ripen from early summer until frost. Some of the seeds may germinate immediately after falling to the ground but many of them lay dormant on the soil surface for 5 years or more before germinating.

DISEASE-CONTROL CHEMICALS

Chemicals of this nature control or prevent one type of disease organism. However, in exceptions, a strong fumigant may kill all living organisms in

a given place. The different types of disease control chemicals follow:

Fungicide—A chemical that prevents, inhibits or kills the growth of fungi.

Nematocide—A chemical that kills nematodes. For the most part we think of chemicals that volatize and diffuse throughout the soil.

Bactericide—A chemical that controls bacterial infection. There are few satisfactory chemicals for the control of bacterial infections in living plants.

TOLERANCES

The word "tolerance" when applied to disease control chemicals restricts the use of a chemical. This protective restriction, administered by the Food and Drug Administration, is intended to keep the use of the chemicals within prescribed limits. This protects the health of human beings or animals who will eat the treated plants.

The chemical application should be made a specified number of days before harvest so that the chemical will break down and leave no harmful residue. The strength of the chemical to be applied is important. Carefully follow directions, particularly when mixing sprays. Recommendations usually are printed on the container. Failure to observe these directions may seriously endanger your health or the health of others.

METHODS OF CONTROLLING PLANT DISEASES

Seed Treatment

Seed treatment is effective against microorganisms that cling to the outer surface of the seed. Seed-treating chemicals can kill these organisms, but not those within the seed. Bacteria which cause bacterial blight of cotton are examples of organisms found on the outside and inside of the seed.

Some measure of protection against soil organisms may be gained when planting chemically treated seed. However, presently used seed treatments will not control seedling diseases. Protection is effective during the first stages of germination, but not after the roots and tops begin to grow out of the treated zone.

Seed treatment is important and necessary. Therefore, it is a good practice to treat all seeds that are to be planted. Legume seed may be chemically treated several weeks prior to planting. Bacterial inoculant should be applied to the legume seed just before planting.

Spraying Plants

Spraying is a method whereby a liquid or wettable powder is mixed with a solvent. In most cases, this solvent is water.

Chemicals usually are applied as sprays to control leaf spotting diseases. They are most effective when applied before the attack, thus serving as a preventive measure. With many crops, the occurrence of these attacks is predictable on the basis of past experience.

Dusting Plants

One may use dusts when controlling diseases with chemicals, but they are not as effective as spraying. Usually, dusts should be used to supplement sprays. Dust preparations are ready-mixed in the proper concentration, ready for application.

Crop Rotation and Sanitation

During the winter many plant disease organisms may live in old infected plant material undergoing decay. In such instances this material acts as a reservoir for the disease organism from season to season. In fields, old plant material may be plowed under to reduce the reservoir of diseased material. Old vines and leaves from the backyard garden should be gathered and burned. Although burning is helpful in disease control, it can in time deplete soil of the organic matter necessary for good crop production. Therefore, when burning old plant material, replenish your soil organic material by turning under cover crops.

Crop rotation also controls plant diseases. It may be necessary to wait several years before planting the same crop again. In such cases knowledge of the life history of the organism can be a guide for the length of rotation.

Resistant Varieties

Planting disease-resistant varieties can be the most economical way to control a disease. For many years plant breeders have been experimenting with the disease resistance of various crops and ornamental plants. Some plants have shown excellent disease-resistant characteristics. When this

is known and the plant variety is adaptable to the area, it should be considered for planting.

Information regarding disease resistance of various crop varieties can be obtained from your local county agricultural agent. Commercial seed companies handling vegetable and ornamental plants usually print seed catalogues containing disease-resistant qualities of various plant varieties.

SOIL TREATMENTS

Small Plots

Heat Treatment

Steam—Steam is an effective method of killing plant disease organisms in the soil. Special steam-generating equipment is needed; however, it may not be available. Steam may be distributed through the soil by drain tile or iron pipes with holes for its escape. Treatments which maintain 180 degrees F. throughout the soil for 30 minutes are adequate. Putting an Irish potato in the soil and waiting for it to bake thoroughly is a good testing procedure.

Dry Heat—Small quantities of soil used in flower pots may be sterilized by placing in an oven set at 160 degrees F. for 3 to 4 hours.

Electricity—Electricity may be used for sterilizing small quantities of boxed soil in which heating cables have been installed. The soil should be treated at 160 degrees F. for 3 to 4 hours.

NOTE: Heating soil above recommended temperatures or for longer periods may disturb the nutrient balance making it less desirable for growing plants.

Application of Chemicals

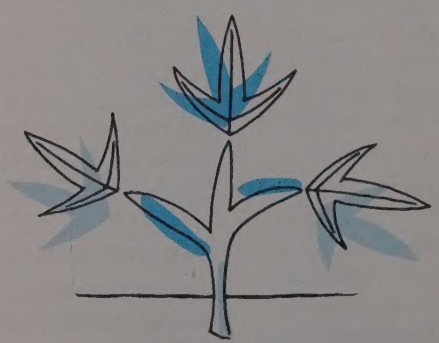
Fumigation—Certain volatile chemicals such as methyl bromide and chloropicrin may be applied to plant beds with good results. Carefully follow the manufacturer's directions when using this method.

Drenches—Some soil fungicides can be applied to soil around growing plants in the form of liquid drenches. This is done primarily to decrease numbers of plant parasitic organisms present in the root zone.

Field Soils

Fumigation—Field scale fumigation is recommended primarily for the control of plant parasitic nematodes. It is gaining widespread acceptance as a profitable management practice, especially where high value crops are involved. Chemicals are injected into the soil at a depth of 6 to 12 inches.

Fungicides mixed in covering soil—This practice has been adapted especially for the control of cotton seedling disease. This too, has proved profitable in many areas. In such a practice, fungicidal chemicals are put in the seedbed at the time of planting; there they protect the young seedling until it becomes well established.



Your County

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